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Attainment, attendance, and school difficulties in UK primary schoolchildren with probable ADHD

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Background. Among children aged 6–16, there is a clear association between attention-deficit/hyperactivity disorder (ADHD) symptoms and academic attainment. We wanted to know whether this association was replicated in younger children.

Aims. To explore the relationship between children aged 4–8 with probable ADHD and their academic attainment and school attendance. Secondly, the study aimed to explore their behaviour within school and their reported attitudes towards school.

Sample. A total of 1,152 children who were taking part in the Supporting Teachers and Children in Schools (STARS) cluster randomized controlled trial.

Methods. ADHD status was established by using the Strengths and Difficulties Questionnaire predictive algorithm to identify children with probable ADHD. Using baseline data, random-effects regression models on ADHD status were fitted to attainment, attendance, special educational needs (SEN) provision, and attitudes towards school and classroom behaviour; models that were also fitted to attainment were evaluated again at 9, 18, and 30 months after baseline.

Results. Children with probable ADHD ($n = 47$) were more likely than controls ($n = 1,105$) to have below-expected attainment in literacy (odds ratio (OR) 16.7, 95% CI 6.93-to-40.1), numeracy (OR 11.3, 95% CI 5.34-to-24.1) and to be identified as having SEN (OR-55.2, 95%-CI 22.1-to-137). Their attendance was poorer with more unauthorized absences (rate ratio (RR)-1.91, 95%-CI-1.57-to-2.31). They had more teacher-reported behavioural problems (mean difference (MD) 5.0, 95%-CI 4.6-to-5.4) and less

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positive attitudes towards school (MD = 1.1, 95% CI = 0.56 to = 1.85). Poorer attainment in literacy and numeracy persisted at all follow-ups.

Conclusions. Children aged as young as 4 whose behaviour indicates probable ADHD struggle to cope at school in terms of academic attainment, attendance, classroom behaviour, and attitude towards school when compared to other children. Early identification and intervention to help these children manage in school are needed.

Attention-deficit hyperactivity disorder (ADHD) is a neurodevelopmental disorder characterized by impairing levels of inattentive and/or hyperactive and impulsive behaviours (American Psychiatric Association, 2013). The estimated prevalence of childhood ADHD in community studies ranges from 2 to 7% (Polanczyk, Willcutt, Salum, Kieling, & Rohde, 2014). ADHD is associated with a range of negative outcomes including poor academic attainment, occupational functioning, disrupted relationships, accidents, addiction, and even premature death (Cuffe *et al.*, 2015; Dalsgaard, Østergaard, Leckman, Mortensen, & Pedersen, 2015; Kendall *et al.*, 2008; Shaw *et al.*, 2012). The onset of ADHD is typically in childhood, but it is widely recognized to be a lifespan disorder with symptoms persisting beyond childhood for many individuals (Agnew-Blais *et al.*, 2016; Faraone, Biederman, & Mick, 2006) (Caye, Spadini, *et al.*, 2016; Caye, Swanson, *et al.*, 2016; Faraone *et al.*, 2006).

Poor outcomes are particularly likely when ADHD is diagnosed late, and are similar for children with high levels of symptoms but without formal diagnosis (Merrell *et al.*, 2017; Washbrook, Propper, & Sayal, 2013). The appearance of symptoms in early childhood is a particular reason for concern; these children are characterized by persisting symptoms and associated impairments (Agnew-Blais *et al.*, 2016; McGee, Partridge, Williams, & Silva, 1991) and incur service use costs that are over 17 times higher than their non-ADHD peers 11–22 years later. These costs are mainly attributed to education, criminal justice, and mental health services (Chorozoglou *et al.*, 2015). Early detection of ADHD and identification of young children at risk for developing ADHD has been recommended (Wolraich *et al.*, 2011) as treatment of symptoms has been shown to improve outcomes (Molina *et al.*, 2009).

A growing body of literature has documented the progress of ADHD-diagnosed schoolchildren over periods of 6–14 years; all have found that most children with ADHD show persistent hyperactivity and inattention, poor school achievement, and a higher rate of disruptive and high-risk behaviour, such as drug taking and criminal activity, than their peers without ADHD (Dalsgaard *et al.*, 2015; Erskine *et al.*, 2016). Parent-reported Strengths and Difficulties Questionnaire (SDQ) hyperactivity/inattention and conduct problems measured at age 3 have even been shown to predict later GCSE attainment (Washbrook *et al.*, 2013); abnormal hyperactivity/inattention scores predicted reductions of ten GCSE points in boys. A very large cohort study of over 600,000 children born in Denmark found that those with a clinical diagnosis of ADHD were more likely not to take final school examination and those that did achieved significantly lower mean grades than other children (Dalsgaard *et al.*, 2020).

The features of ADHD which have been found to have the greatest effect on academic performance are concentration, inattention, hyperactivity, and lack of planning and organizational skills (Corder *et al.*, 2015; Galera, Melchior, Chastang, Bouvard, & Fombonne, 2009; Sijtsma, Verboom, Penninx, Verhulst, & Ormel, 2014). There is some evidence that inattention is particularly likely to predict failure to obtain a high school diploma and that hyperactivity had no association once inattention was controlled (Pingault *et al.*, 2011), and that ADHD is associated with poorer school attendance at all

levels of education, as well as exclusion from school (Fleming *et al.*, 2017; Lawrence, Dawson, Houghton, Goodsell, & Sawyer, 2019; Parker *et al.*, 2019).

Most research focuses on the links between early ADHD behaviours and later achievement at school leaving age, with very little exploring function within primary school settings. Dutch children who displayed ADHD behaviours during primary school were found to have impaired school functioning at both primary and secondary school, with little evidence that their level of impairment increased as the children aged (Sijtsema *et al.*, 2014). Two studies exploring preschool children with ADHD symptoms suggest that they are more likely to be behind in basic academic readiness (Dupaul, McGoey, Eckert, & Vanbrakle, 2001; Mariani & Barkley, 1997), but the vast majority of previous research is focused on academic attainment at the end of compulsory education (Birchwood & Daley, 2012; Fergusson, McLeod, & Horwood, 2015; Kessler *et al.*, 2014; van der Schans *et al.*, 2016). This is important since primary and secondary schools are very different environments; it is feasible that the educational attainment deficits seen in older children with ADHD will be less evident or absent when these children are at smaller primary settings with fewer teachers and transitions throughout the day.

A variety of psychometric measures have been used to assess levels of ADHD symptoms. The Strength and Difficulties Questionnaire (SDQ) is a widely used dimensional measure of childhood psychopathology (Goodman, 2001). Goodman (Goodman, Ford, Simmons, Gatward, & Meltzer, 2000) explored how accurately the SDQ could be used to predict certain psychopathologies using an algorithm that combined scores from the relevant SDQ symptom items with the reported severity of overall impact for conduct, emotional, and ADHD subscales. In a large sample of over 10,000 British children, the SDQ algorithm identified children with a psychiatric diagnosis assessed independently by multi-informant standardized diagnostic assessment with a specificity of 95% (95% CI: 94–95%) and a sensitivity of 63% (95% CI: 60–67%). The algorithm was particularly effective at identifying ADHD with 75% of all cases detected via their SDQ scores.

In this study, we aimed to fill the important gap in the literature about the academic attainment of children who display ADHD like behaviours within a primary school setting. The primary objective of the current study was to examine academic attainment in a group including younger children with ADHD behaviours than have previously been studied. We used data collected from children aged four to nine from schools in the South West of England who were taking part in the Supporting Teachers and Children in Schools (STARS) trial (Ford *et al.*, 2018). We hypothesized that children with ADHD symptoms would have lower levels of attainment and attendance at school, feel worse about school, display more disruptive behaviour at school, and be more likely to be recognized as having Special Educational Needs (SEN) compared with children whose SDQ scores do not indicate probable ADHD.

Methods

Design and participants

STARS was a cluster randomized controlled trial conducted in 80 primary schools (clusters) in England that tested the impact of the Incredible Years Teacher Classroom Management programme on children's mental health (Ford *et al.*, 2018).

In total, the STARS trial included 2,075 eligible pupils. Full details of the study design are described in Ford *et al.* (2018). Children were ineligible for the trial if their parents spoke insufficient English to understand the participant information sheet ($n = 6$), and

107 children were opted out of the research by their parents. Schools were recruited in three separate cohorts in September 2012 (Cohort 1), September 2013 (Cohort 2), and September 2014 (Cohort 3). Data were collected in October (baseline) and June (9-month follow-up) of the school's first year of participation and then in each of the following 2 years during the Spring Terms at 18 and 30 months, respectively. Eligible schools were state-funded mainstream primary schools. Schools were excluded if they were judged as failing in their last Ofsted inspection (Office for Standards in Education, Children's Services and Skills; the official inspectorate for schools in England), had an acting rather than a substantive headteacher, or who only admitted children with special educational needs.

The study area had a predominantly white British (93.5%) population with some areas of high deprivation (Devon County Council, 2013). Participating schools were from a mixture of urban (54%) and non-urban locations; 18% were located in a deprived area (lowest quintile according to the Index of Multiple Deprivation (IMD: McLennan *et al.*, 2011). More than half of the schools (58%) had higher than the mean proportion of children eligible to receive free school meals in England; an alternate measure of deprivation (Department of Education, 2012).

Outcomes

Psychopathology

Parents and teachers completed the SDQ at baseline (Goodman, 2001). The SDQ is a widely used dimensional measure of childhood psychopathology that has been shown to be valid and reliable (internal consistency, Cronbach's $\alpha = 0.73$; cross-informant correlation, Pearson's correlation coefficient (r) = 0.34; mean retest stability after 4–6 months, Pearson's correlation coefficient (r) = 0.62) (Goodman, 2001). It comprises 25 items that cover 5 domains each with five items: emotional symptoms, conduct problems, hyperactivity/inattention (ADHD), peer relationship problems, and prosocial behaviour. Each item asked about a different facet of the child's behaviour, for example 'This child is generally obedient, usually does what adults request' and is scored corresponding to the following anchors 'not true' (0), 'somewhat true' (1) or 'certainly true' (2). Half the items are positively, and half are negatively phrased (with reverse scoring) so that higher scores indicate greater difficulty for the first four domains and the converse for the prosocial domain. The emotional symptom, conduct problem, hyperactivity/inattention (ADHD), and peer relationship problem domains are summed to produce a total difficulty score (range 0–40).

The SDQ *Impact* supplement asks parents and teachers if they perceive the child as having any emotional or behavioural difficulty, which we classified as yes (respondent answers 'yes definitely' or 'yes severe' or no ('yes minor' or 'no'). Respondents that perceive a difficulty are asked an additional three questions if they are teachers (possible score of 0–6) or five questions if they are parents (possible score of 0–10) about the extent to which difficulties in the areas of emotions, concentration, behaviour, or being able to get on with other people impact upon the child. Both informants answer questions on everyday life in terms of peer relations and classroom learning, and parents have additional questions on family life and leisure activities on the following scale; 'Not at all' or 'Only a little' (0), 'quite a lot' (1), or 'A great deal' (2).

Separate to the SDQ questionnaire, Goodman and colleagues developed a post-completion computer algorithm (Goodman, Ford, *et al.*, 2000; Goodman, Renfrew, & Mullick, 2000) that combines data from teacher and parent SDQ scores to indicate

whether each child was unlikely, possibly, or probably demonstrating psychopathology in the following domains: emotional disorder, conduct disorder or ADHD, (see <https://web.archive.org/web/20181017204411/http://www.sdqinfo.com/c8.html> for further details and Appendix 1 for an example). Under this algorithm, a disorder is considered probably present if the scores on the relevant symptom indicate the child is above the 95th centile and the impact score is 2 or above. Analysis of 18,232 children in two national population surveys, described in the British Child and Adolescent Mental Health Survey 1999 (Algorta, Dodd, Stringaris, & Youngstrom, 2016), demonstrated that the SDQ was an excellent screening tool for ADHD. The area under the curve (AUC) ranged from 0.91 to 0.96 with no significant differences in AUC found between gender or age groups. The diagnostic likelihood ratios (DLR) ranged from 2.3 when the ADHD domain score was ≥ 5 to 21.3 when the domain score was 10. For emotional and conduct disorders, such scores from one informant are sufficient to allocate a probable diagnosis, but for ADHD, both teacher and parent reports have to be in this range because of the requirement for pervasive difficulties across settings (American Psychiatric Association, 2013). Because of this higher threshold for ADHD diagnosis, we excluded children who did not have both parent and teacher SDQ scores. While the distribution of teacher SDQ scores in STARS baseline closely matched national norms, fewer-than-expected children with parental SDQ reports (16% compared with 20%) scored in the vulnerable range, which suggests that the sample analysed for the current analysis excluded some of those most likely to have psychopathology (Ford *et al.*, 2019). Notably, 14% were rated by their teacher as having high levels of ADHD type behaviour compared with only 8% whose parents did complete an SDQ.

Our aim was to compare the children with probable ADHD (who may or may not also have probable conduct disorder), with a comparison group who had no psychopathology (see Figure 1). We therefore excluded children with SDQ scores suggesting probable emotional disorder. Since conduct disorder and probable ADHD are highly comorbid (Forbes *et al.*, 2018), children whose SDQ scores were consistent with a probable diagnosis of ADHD *and* conduct disorder ($n = 26$) were included in the analysis. Children with probable conduct disorder but not ADHD were also excluded from the comparison group.

Academic attainment and school attendance

At each follow-up, teachers rated the children according to their academic progress in both numeracy and literacy. These ratings were compared to the expected level for their age and dichotomized as 'Below age-related expected attainment' or 'At or above age-related expected attainment'. School attendance data during the study were collected from the National Pupil Database, reported as 'Authorised' or 'Unauthorised' absence by the school. The number of sessions absent was divided by total sessions of school in that academic year to quantify absence as a percentage of available sessions.

Demographic characteristics

Socio-demographic characteristics were collected from several sources. Socio-economic status was defined based on the Income Disadvantage Affecting Children Index (IDACI), which is produced by central government and measures the proportion of the population in an area, defined by home postcode, experiencing deprivation relating to low income. It is reported in decile-based categories from one (most disadvantaged) to ten (least

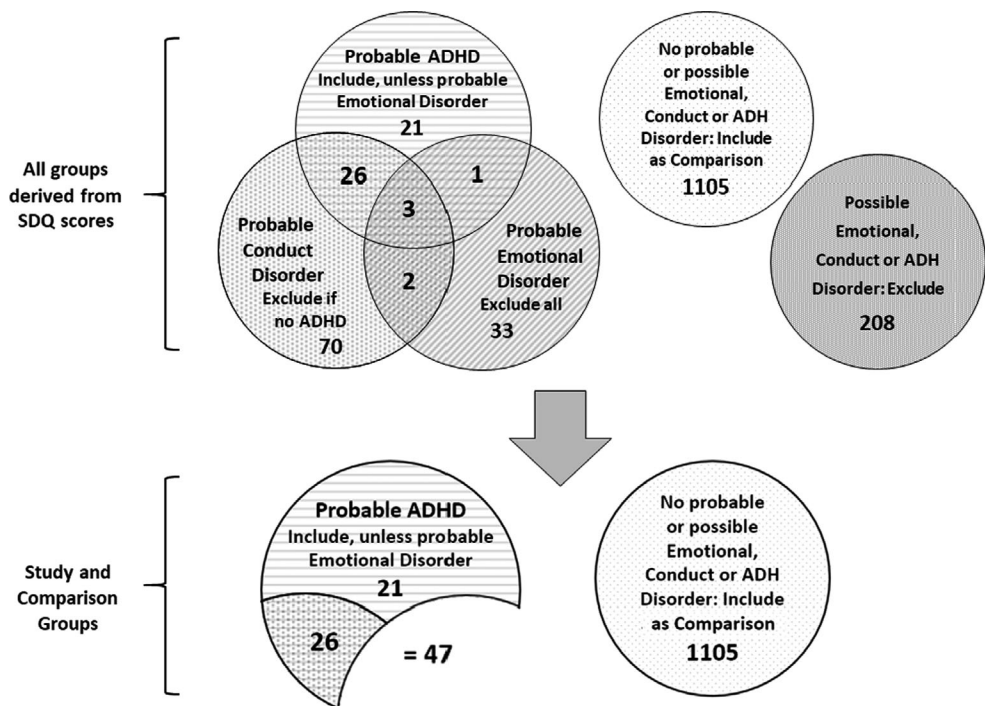


Figure 1. Venn diagram identifying the make-up of the probable ADHD and comparison groups. Note: ADHD – attention-deficit hyperactivity disorder; ADH disorder – attention-deficit hyperactivity disorder; SDQ – strengths and difficulties questionnaire.

disadvantaged). This was dichotomized, comparing children from the most deprived bottom two decile-based categories with those from the higher 8 categories. We also used the child’s relative age in the year group, as this is associated with mental health and SEN in this and other samples; relative maturity correlating with better mental health and educational adjustment (Goodman, Gledhill, & Ford, 2003; Price, Allen, Ukoumunne, Hayes, & Ford, 2017). Relative age was used as a continuous variable with zero being the youngest possible for the year group and one being the eldest.

Special educational needs

The Special Educational Needs Co-ordinator (SENCo) from each school reported whether each child had additional educational needs (yes or no), but the type and level of provision were not reported.

Children’s classroom behaviour

Teachers completed the Pupil Behaviour Questionnaire (PBQ: Allwood *et al.*, 2018) which measures low level classroom-based disruptive behaviours commonly displayed by primary school aged children. The PBQ has high levels of internal consistency (Cronbach’s α 0.85) and includes six questions about the child’s behaviour within the classroom, for example ‘Interrupting other pupils, for example, by distracting them from work’ scored to indicate the frequency of these behaviours as never (0), occasionally (1)

or frequently (2). These questions can be summed to give a total score (range 0–12) with higher scores indicating more disruptive behaviour.

Children's attitude towards school

Children completed the How I Feel About My School measure (HIFAMS: Allen *et al.*, 2017) which uses age-appropriate language and pictures to capture attitudes towards school and includes 7 items asking children how they feel about their school, relationships with their peers, teacher, and learning, for example 'On the way to school I feel...'. Children respond by circling one of three schematic faces to indicate whether in each situation they feel happy (2), okay (1), or sad (0). Items are summed to give a total HIFAMS score with a range between 0 and 14, with higher scores indicating greater happiness at school. HIFAMS has been found to have moderate internal consistency (Cronbach's $\alpha = 0.62$) in primary schoolchildren and to differentiate between children at risk of permanent exclusion and the mainstream school population (Allen *et al.*, 2017). HIFAMS scores ranged from 0 to 10 (mean 7.71, standard deviation 1.95) among 5,576 English primary schoolchildren aged 4–9 years, although no established cut-points are available (Harrison, 2020).

Analysis

Participant characteristics were summarized using means and standard deviations for continuous variables, and numbers and percentages for categorical variables. Using baseline data, regression models exploring the cross-sectional relationship between probable ADHD status (predictor) and each outcome were fitted and adjusted for gender, age in years, relative age in the year group and socio-economic status as covariates. The binary outcomes attainment in literacy and numeracy, and the presence of SEN were compared between the probable ADHD and no ADHD groups using logistic regression, reporting odds ratios (OR). Information sandwich ('robust') estimates of standard error were obtained to account for the correlation between responses of children from the same school (cluster) for the binary outcomes. The variables recorded as counts (total absence days and unauthorized absence days) were compared using random-effects Poisson regression, reporting rate ratios (RR). The continuous outcomes PBQ and HIFAMS scores were compared using random-effects linear regression, reporting mean differences between groups. The random-effects models specified random effects (intercepts only) for the schools to account for the correlation between responses of children from the same school (cluster). All analyses were conducted with Stata version 15.1 (StataCorp, 2015).

Differences in attainment between those with probable ADHD and the comparison group were also assessed longitudinally at the three subsequent timepoints over the follow-up period. Logistic regression models were fitted using attainment in literacy and numeracy as outcomes at 9-, 18-, and 30-month follow-up, controlling for the same covariates, but also including trial arm allocation as a covariate because an intervention effect was found in the STARS trial on the ADHD subscale and the PBQ (Ford *et al.*, 2018).

Most teachers used a web-based electronic data-capture system to complete all questionnaire measures on the children, which did not allow items to remain unmarked. Parents and children completed paper measures and missing items were pro-rated in accordance with the established conventions provided a minimum of three items were answered for each subscale (Goodman, 2016).

Results

Descriptive statistics

Sample population – Results from SDQ algorithm

From the total sample of 2,075 children in the STARS study, 1,469 children had SDQ scores from both teachers and parents at baseline, which was 71% of the total STARS sample. As indicated by Figure 1, of those 1,469 children, the SDQ algorithm (Goodman, Renfrew, *et al.*, 2000) identified 1,105 children (78%) without a probable emotional, conduct disorder, or ADHD (comparison children), 208 with a possible but not probable emotional, conduct disorder, or ADHD (excluded), and 39 children with a probable emotional disorder (3%, excluded). A total of 70 had probable conduct disorder alone and were excluded. A total of 51 children were identified with probable ADHD (3%), 4 of these children were identified as also having a probable emotional disorder and were therefore excluded, leaving 47 children with probable ADHD.

Children with probable ADHD contained a much higher proportion of boys than the comparison group, where gender was equally divided, as would be expected given the predominance of neurodevelopmental problems among boys (Forbes *et al.*, 2018). Age and relative age were similar between the groups, but children with probable ADHD were more likely than comparison children to be in the bottom two IDACI deciles (most deprived areas) than the top four (see Table 1).

Main analysis

As shown in Table 2, compared with our comparison sample, children with probable ADHD were more likely to attain below the expected level in literacy (adjusted odds ratio (OR) 6.3, 95% confidence interval (CI): 3.0–13.3, $p < .001$) and numeracy (OR 5.6, 95% CI: 2.9–10.8, $p < .001$). They were also more likely to have SEN provision (OR 35.8, 95% CI: 16.1–79.7, $p < .001$), and to be absent from school (rate ratio (RR) 1.6, 95% CI: 1.4–1.8 $p < .001$). In fact, children with probable ADHD had double the rate of unauthorized absence (RR 2.2, 95% CI: 1.8–2.7, $p < .001$). Teachers reported higher scores on the PBQ (mean difference 5.0, 95% CI: 4.6–5.4, $p < .001$) indicating more disruptive classroom behaviour, while pupils reported lower scores on the HIFAMS indicating the children had less favourable perceptions of school (mean difference –1.2, 95% CI: –0.5 to –1.8, $p = .001$) (see Table 2).

Table 1. Demographic characteristics at baseline

	Probable ADHD N = 47	Comparison N = 1,105
Male, n (%)	41 (87.2%)	529 (47.9%)
Age (years), mean (SD; range)	6.9 (1.0; 4–8)	6.7 (1.4; 4–8)
Relative age (years), mean (SD)	0.5 (0.3)	0.5 (0.3)
Bottom 2 decile-based categories IDACI, n (%)	12 (25.5)	169 (15.3)

ADHD = attention-deficit/hyperactivity disorder; IDACI decile = Income deprivation affecting children index with lower deciles indicating higher deprivation; SD = standard deviation; N = sample size; n = number with characteristic; relative age is 1 if eldest possible in year group and or 0 if youngest possible.

Table 2. Comparison of function at school between children with probable ADHD and comparison sample

Outcome	Probable ADHD N = 47		Comparison N = 1,104		Crude analysis		Adjusted analysis	
					Odds ratio		Odds ratio	p-value
Literacy below standard, n (%)	36 (76.6)		350 (31.7)		7.1		6.3	<.001
Numeracy below standard, n (%)	29 (61.7)		266 (24.1)		5.1		5.6	<.001
Special educational needs, n (%)	39 (83.0)		117 (10.6)		41.2		35.8	<.001
	N = 47	N = 1,104	Mean difference		Mean difference		95% confidence interval	p-value
PBQ, mean (SD)	6.3 (2.6)	1.1 (1.4)	5.3		5.0		4.6 to 5.4	<.001
HIFAMS, mean (SD)	10.1 (3.2)	11.2 (2.2)	-1.2		-1.2		-0.5 to -1.8	.001
	N = 26	N = 693	Rate ratio		Rate ratio		95% confidence interval	p-value
Total absence, mean % (SD)	4.6 (4.0)	3.0 (2.9)	1.6		1.6		1.4-1.8	<.001
Unauthorized absence, mean % (SD)	1.6 (3.1)	0.8 (1.8)	2.3		2.2		1.8-2.7	<.001

Logistic regression of academic attainment and special education needs; linear regression of Pupil Behaviour Questionnaire (PBQ, scored 0-12 higher being worse) and How I Feel About My School (HIFAMS, scored 0-14 higher being better) scores; Poisson regression of school absence; all comparisons were adjusted for relative age in school year, gender, age in years, and socio-economic status. Absence figures are expressed as a proportion of total school days. ADHD - attention-deficit/hyperactivity disorder SD = standard deviation of the mean; N = sample size; n - number with characteristic. The number of comparisons was 1,104 because one pupil lacked data for the relevant measures except for PBQ. Attendance data were partial leading to a smaller sample.

Longitudinal analysis of academic attainment

As shown in Figure 2, the academic attainment of children with probable ADHD was lower than the comparison group at all three follow-ups (9 months: Numeracy OR 8.4, 95% CI: 4.2–16.8; Literacy OR 10.2, 95% CI: 4.6–22.3; 18 months: Numeracy OR 8.5, 95% CI: 4.1–17.5, Literacy OR 9.4, 95% CI: 4.2–21.1; 30 months: Numeracy OR 5.9, 95% CI: 2.6–14.0, Literacy OR 7.1, 95% CI: 3.1–16.0).

Discussion

Findings

We found strong relationships between probable ADHD and difficulties at school in children aged between 4 and 9, both in cross-sectional and in longitudinal analyses. Children whose teacher- and parent-completed SDQ scores indicated they probably had ADHD fared worse in both literacy and numeracy over a 30-month follow-up period. As expected, children with probable ADHD were more likely to have been identified as having special educational needs and teacher-reported classroom behaviour was more troublesome than for their peers. Children with probable ADHD reported feeling less happy in school than the comparison group, and their absence rates were higher. While adjusting our models for key confounders reduced the strength of the associations, a strong independent association persisted. Our findings add to the evidence base that children who struggle to focus attention and control motor activity are at risk of poor academic attainment throughout their education and add clarity that this deficit starts very young. Early intervention that improves attention and emotional regulation may have a knock-on effect on later attainment, while academic interventions at GCSE stage may be too late to improve this trajectory, which our study suggests is evident in a group including children as young as 4 years old.

Only a small proportion of children with ADHD are referred to Children and Adolescent Mental Health Services in the United Kingdom (CAMHS) (Mandalia *et al.*, 2018), and even if referred, waiting lists are lengthy and the diagnosis is sometimes delayed for several years (Longridge, Norman, Henley, Newlove-Delgado, & Ford, 2018; Sayal, Prasad, Daley, Ford, & Coghill, 2018). Therefore, our findings suggest that support for teachers to help focus attention and manage associated behavioural disturbance is a priority. For example, a recent multi-method systematic review reported tentative evidence for daily report cards to improve consistent communication between home and school for children with ADHD (Moore *et al.*, 2018). The associated qualitative comparative analysis suggested that strategies that improve self-regulation and are delivered one-to-one were commonly among the most effective interventions for academic outcomes, particularly if combined with personalized programmes and delivered in the classroom. The evidence, however, was of poor quality, so these conclusions can only be tentative. There remains an urgent need to develop simple effective strategies that educators can apply to support children with ADHD in schools.

Strengths and limitations

Our sample was drawn from schools who had elected to join a randomized controlled trial and was not representative of the UK population, but it was representative of West Country schools. The region has a low number of children with Black and minority ethnic backgrounds so our findings may not therefore be generalizable to populations with greater ethnic diversity.

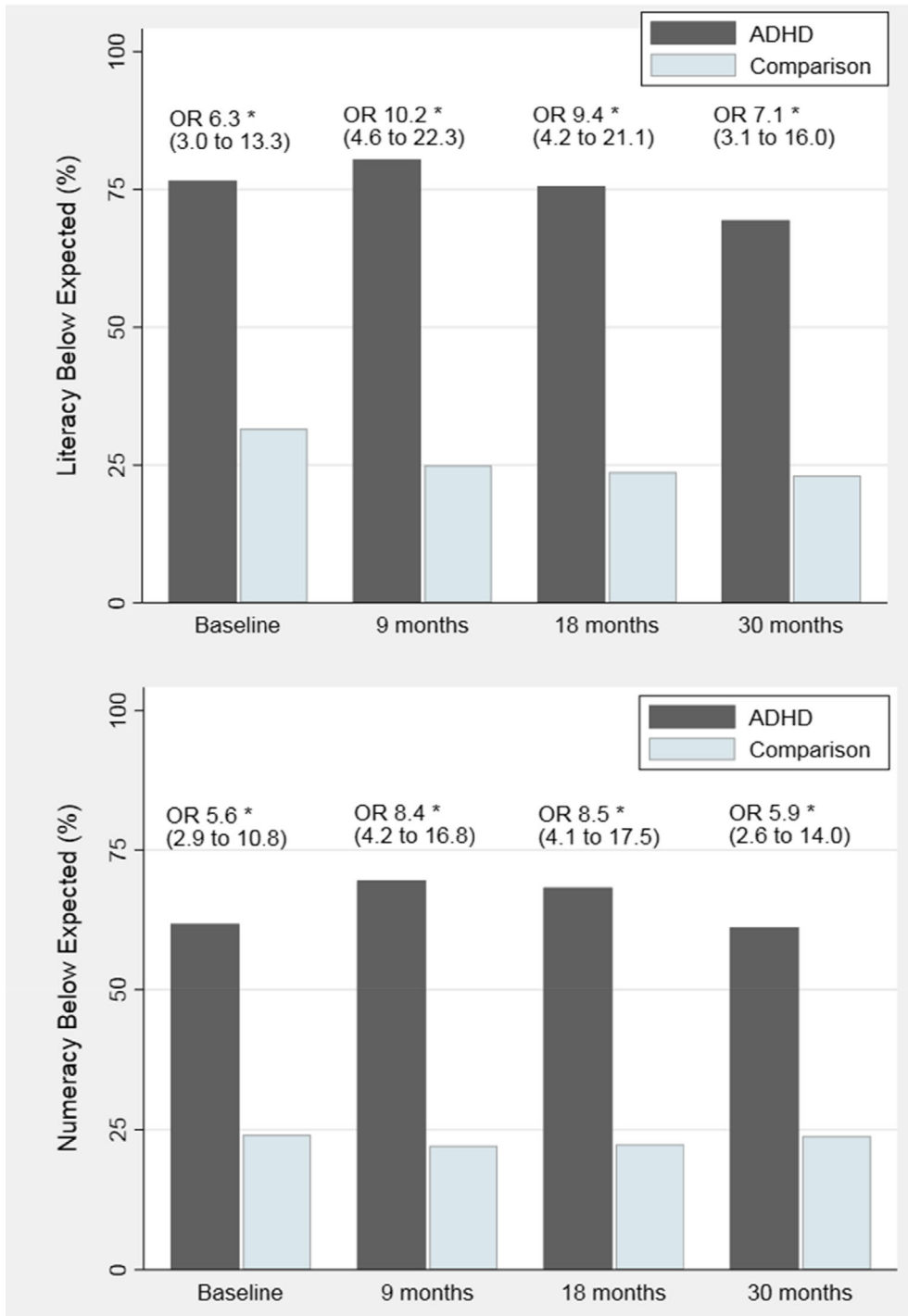


Figure 2. Attainment in literacy and numeracy adjusted for relative age, gender, age in years, and socio-economic status, over time in probable ADHD versus comparison group. Note: Chart: OR = Adjusted odds ratio; 95% confidence intervals in brackets; * $p < .001$.

We compared the function of children with ADHD against their peers who were ‘unlikely’ to have a mental health disorder of any type on teacher and parent report. If we had included the children with possible disorders, we would have compared children with ADHD against other children, which is a different question. As poor mental health has demonstrated impacts on academic attainment in primary school students (Deighton *et al.*, 2017; Panayiotou & Humphrey, 2017), we consider the comparison of children with ADHD against those with little or no psychopathology as the most appropriate question to pose, but the use of a particularly healthy comparison group will have accentuated the difference between the two groups.

There were a small absolute number of children with probable ADHD, as would be expected in a community sample, which necessarily restricted the precision we had to estimate differences and associations. The prevalence of ‘probable ADHD’ in this sample is within the lower end of ADHD prevalence rates reported in other studies (Polanczyk *et al.*, 2014). There are other ways in which scores on the SDQ could have been dichotomized, for example using established cut-points from a single informant as others have (Caye *et al.*, 2020; Riglin *et al.*, 2016). Our application of the pseudo-diagnostic algorithm to combine data from both parents and teachers and incorporate impact into the selection of children with probable ADHD will have better focused our analysis on children with clinically impairing levels of ADHD than the use of a single informant and ignoring impairment. The choice of cut-point needs to reflect the question asked, and for some studies, a broader sample to include those with borderline symptoms is perfectly justifiable (Caye *et al.*, 2020; Riglin *et al.*, 2016).

There will, however, inevitably be some misclassification and exclusions related to the SDQ. The SDQ algorithm is not a diagnostic measure, although it demonstrates reasonable sensitivity and strong specificity. We would therefore expect proportionally more false negatives than false positives. For example, some children with diagnosable ADHD could be high functioning enough to only be scored ‘possible ADHD’ or ‘unlikely ADHD’ from the SDQ and would have not been included in the probable ADHD group (false negatives). There will also be children classified by the SDQ as ‘probably ADHD’ who, on specialist assessment, would not be diagnosed as such (false positives). In terms of frequency, the false negatives could be significant in proportion to the size of the probable ADHD group, and this may account for the slightly low prevalence in our study. If we assume that many of the false negatives comprise the type of children that would have been excluded from this study (e.g., those in the ‘possible ADHD’ category), then the spectrum of ADHD would be less severe in our ADHD group than it should be and if these excluded, false negatives were phenotypically milder than the included true positives that could have magnified the differences in outcome between the probable ADHD and comparison groups.

Also notable is that the exclusion of children without a parental report may have skewed the population towards healthier function and lower prevalence. Of the 606 children, we removed from our analysis due to parents not completing an SDQ; 14% of them were rated by their teacher as having high levels of ADHD type behaviour compared with only 8% of those whose parents did complete an SDQ. Therefore, it is plausible that those 606 children contained a higher proportion with ADHD phenotypes and possibly a trend towards greater severity. One can speculate on why households not completing their part of survey might be different, but we did not have the data to investigate this.

Given that in practice many children with ADHD will not receive a clinical diagnosis (Mandalia *et al.*, 2018), the use of an accessible screening measure such as the SDQ may

identify those most in need of early support in order to optimize potential academic outcomes, regardless of whether they receive a clinical diagnosis. The focus of a questionnaire and the number of items will determine its sensitivity to change and predictive power (Lee, Jones, Goodman, & Heyman, 2005). Kersten *et al.* (2016) found poor evidence for cultural validity, criterion validity and test–retest reliability when the SDQ is used in children aged 3–5 years. While our results would not have been impacted by cultural variations, it is possible that for some of the younger children the SDQ may have lacked precision. As the SDQ was designed to assess common psychopathology relevant to clinical mental health practice, rather than ADHD in particular, other ADHD-specific questionnaires might be more appropriate to assess for ADHD if this condition alone was being considered. A more detailed ADHD measure, such as the Conners Scale (Conners, 1997), might have provided a closer approximation to clinical diagnosis and might have allowed the study of inattentive and hyperactive subtypes. The selection of measures needs to relate to the question the practitioner or researcher is asking but as this was a secondary analysis, we were constrained by the data that were available.

Although we adjusted for key known confounders, we cannot exclude residual confounding or unknown risk factors, but it seems unlikely such factors would completely explain the strong effects that we detected. We considered that participation in the intervention arm of the original trial resulted in improved concentration but this was adjusted for in the regression models and a residual effect of exposure to the intervention is unlikely.

The small numbers and low proportion of girls with probable ADHD meant that we lacked sufficient statistical power to stratify our analyses by gender. This is not surprising as many studies report that girls are less likely to have ADHD than boys, but it is worth noting that girls that *do* have ADHD are less likely to be identified, referred, and treated (Russell *et al.*, 2019). The relationship between probable ADHD and academic attainment could differ between boys and girls. For example, Smith *et al.* (2017) found that there was a stronger association between preschool hyperactivity and poorer longer term mental health outcomes in males.

Future research

Reviews of interventions for children with ADHD in school settings demonstrate that interventions focusing on academic skills to improve academic outcomes tend to be trialled and presumably intended for older children than those in our sample (Moore *et al.*, 2018). Therefore, early intervention that targets the attainment gap for young children with ADHD symptoms should be encouraged. Further research into early adaptations that school staff can feasibly put in place to promote and reinforce learning in primary school years may result in effective improvement in academic outcomes for these children.

Conclusion

We have demonstrated that a group of children aged 4 to 9 whose behaviour indicates probable ADHD struggle to cope at school in terms of academic attainment, attendance, classroom behaviour, and attitude towards school when compared to their peers without psychopathology. Methods for early identification with active treatment and remediation should be explored to try and reduce the associated impact on education and consequently on future life chances.

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Author contributions

Felix May, Bsc BMBS: Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Project administration; Resources; Software; Supervision; Validation; Visualization; Writing – original draft; Writing – review & editing. Tamsin Ford: Conceptualization; Data curation; Funding acquisition; Investigation; Methodology; Project administration; Resources; Supervision; Validation; Writing – original draft; Writing – review & editing. Astrid Janssens: Formal analysis; Methodology; Supervision; Writing – original draft; Writing – review & editing. Tamsin Newlove-Delgado: Formal analysis; Methodology; Resources; Software; Validation; Writing – original draft; Writing – review & editing. Abigail Emma Russell: Formal analysis; Methodology; Resources; Validation; Visualization; Writing – original draft; Writing – review & editing. Javid Salim: Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Writing – review & editing. Obioha Ukoumunne: Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Resources; Software; Supervision; Validation; Writing – original draft; Writing – review & editing. Rachel Hayes: Conceptualization; Data curation; Formal analysis; Funding acquisition; Investigation; Methodology; Project administration; Resources; Software; Supervision; Validation; Visualization; Writing – original draft; Writing – review & editing.

Conflicts of interest

All authors declare no conflict of interest.

Ethical approval

Ethical approval was obtained from the Peninsula College of Medicine and Dentistry Research Ethics Committee (12/03/141).

Data availability statement

Data sharing is not applicable to this article as no new data were created or analysed in this study.

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Appendix I:

A table detailing the sub-total SDQ scores that indicate an unlikely, a possible, or a probable psychopathology, including an example of a child's score for each category

	Parent domain example scores			Teacher domain example scores				
	Emotional	Conduct	ADHD	Impact	Emotional	Conduct	ADHD	Impact
ADHD								
Unlikely If BOTH parent and teacher hyperactivity/inattention (ADHD) domain score is < 6	2	1	4	0	3	2	3	0
Possible If EITHER parent or teacher hyperactivity/inattention (ADHD) domain score is 6, 7 or 8 with impact score = 1	3	1	6	1	4	2	4	0
Possible If EITHER parent or teacher hyperactivity/inattention (ADHD) domain score is >=9 with impact score = 1	1	2	9	1	1	2	1	0
Probable If BOTH parent and teacher hyperactivity/inattention (ADHD) domain score is >=7 with impact score >=2	1	2	8	6	0	1	9	2
Probable If BOTH parent and teacher hyperactivity/inattention	1	2	10	1	2	2	9	1

Continued

Appendix 1. (Continued)

	Parent domain example scores			Teacher domain example scores		
	Emotional	Conduct	ADHD	Emotional	Conduct	ADHD
(ADHD) domain score is ≥ 9 with impact score = 1 Conduct disorder Unlikely	1	0	3	2	0	7
If parent conduct problems domain score < 4 AND teacher conduct problems domain score < 3						
Possible						
If parent conduct problems domain score ≥ 4 OR teacher conduct problems domain score ≥ 3	2	4	9	2	1	7
Probable						
If parent conduct problems domain score ≥ 5 and impact ≥ 2	3	6	5	0	2	7
Probable						
If teacher conduct problems domain score ≥ 4 and impact ≥ 2	3	1	3	4	4	6
Emotional disorder						
Unlikely						
If BOTH parent and teacher emotional symptoms domain score is < 6 and both their impact scores = 0	4	1	3	2	0	3

Continued

